- 1 -   **IAP20 Rec'd PCT/PTO 30 DEC 2005**

Description

Method for adjustment of a rotation rate sensor

5   The invention relates to a method for adjustment of a rotation rate sensor having a vibration gyro, which, with a first input and a first output, is part of a primary control loop which excites the vibration gyro by supplying an excitation signal to the first input at its natural frequency, in which case the
10   vibration gyro, with a second input and with a second output, is also part of a secondary control loop, in which case an output signal can be tapped off from the second output and, after amplification and analog/digital conversion, is demodulated to form an in-phase component and a quadrature
15   component, in which case the components are modulated again after filtering and are combined to form a driver signal which is supplied to the second input, and in which case a rotation rate signal is derived from the in-phase component.

20   In the case of rotation rate sensors having a vibration gyro, which are operated with the measures mentioned in the introduction being carried out, not only is the variation in the output signal caused by the Coriolis force included in the rotation rate signal, but also an inadvertent phase shift which
25   is caused by delay times in the components which form the at least one control loop.

One object of the present invention is to minimize these influences on the rotation rate signal.
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According to the invention, this object is achieved in that, when the vibration gyro is not moving, correction values are added to the in-phase components and to the quadrature components and are varied until the in-phase component and the
35   quadrature component are each at a minimum, and in that these

correction values are stored in a non-volatile memory and are used during operation of the rotation rate sensor.

5   The method according to the invention is preferably carried out within a final adjustment process during the production of the rotation rate sensor. The non-volatile memory is in this case used for even further correction and initialization variables, and therefore does not need to be provided just for the method according to the invention.

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The invention allows numerous embodiments. One of these will be described in the following text and is illustrated schematically in a plurality of figures in the drawing, in which:

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Figure 1   shows a block diagram of a rotation rate sensor, and

Figure 2   shows a more detailed illustration of a secondary control loop in the rotation rate sensor.

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The exemplary embodiment as well as parts of it are admittedly shown in the form of block diagrams. However, this does not mean that the arrangement according to the invention is restricted to an implementation using individual circuits

25   corresponding to the blocks. In fact, the arrangement according to the invention can be implemented particularly advantageously using large-scale-integrated circuits. In this case, microprocessors may be used which, when suitably programmed, carry out the processing steps illustrated in the block

30   diagrams.

Figure 1 shows a block diagram of an arrangement having a vibration gyro 1 with two inputs 2, 3 for a primary excitation signal PD and a secondary excitation signal SD. The excitation

35   is provided by means of suitable transducers or converters, for

example electromagnetic transducers. The vibration gyro
furthermore has two outputs 4, 5 for a primary output signal PO
and a secondary output signal SO. These signals reproduce the
respective vibration at physically different points in the
5   gyro. Gyros such as these are known, for example, from
EP 0 307 321 A1 and are based on the Coriolis force effect.

The vibration gyro 1 represents a high Q-factor filter, in
which the path between the input 2 and the output 4 is part of
10   a primary control loop 6, and the path between the input 3 and
the output 5 is part of a secondary control loop 7. The primary
control loop 6 is used to stimulate oscillations at the
resonant frequency of the vibration gyro at, for example,
14 kHz. The stimulation is in this case applied on one axis of
15   the vibration gyro with respect to which the oscillation
direction that is used for the secondary control loop is offset
through 90°. The signal SO is split in the secondary control
loop 7 into two quadrature components, one of which is passed
via a filter 8 to an output 9, from which a signal which is
20   proportional to the rotation rate can be tapped off.

A major proportion of the signal processing is carried out
digitally in both control loops 6, 7. The clock signals which
are required for signal processing are produced in a crystal-
25   controlled digital frequency synthesizer 10, whose clock
frequency in the illustrated example is 14.5 MHz. The primary
control loop will not be described, since this is not necessary
for understanding of the exemplary embodiment.

30   The secondary control loop 7 is illustrated in the form of a
block diagram in figure 2 and contains an amplifier 25, an
anti-aliasing filter 26 and an analog/digital converter 27.
Splitting into the real part and the imaginary part is carried
out with the aid of multipliers 28, 29, to which the amplified
35   and digitized signal SO is supplied, with the I and Q

components, which have not yet been separated, and the carriers
Ti1 and Tq1.
The two components then each pass through a (sinx/x) filter 30,
31 and a low-pass filter 32, 33, respectively. Two signals R1
5   and R2, which represent the rotation rate to be measured by the
rotation rate sensor, are derived by means of a preprocessing
circuit 34 from the filtered real part. The signals R1 and R2
differ in that the signal R2 does not occupy the entire
amplitude range for example from 0V to +5V that is possible
10   with the circuit technology that is used. The signal R2 is set
to zero in order to output a fault message, which the connected
system identifies as a fault message.

The low-pass filters 32, 33 are followed by a respective adder
15   35, 36. The two components Si and Sq, respectively, are then
remodulated with the carriers Ti2 and Tq2, by means of
multipliers 37, 38. An addition process at 39 once again
results in a 14 kHz oscillation, which is converted in an
output driver 40 to a current which is suitable for stimulation
20   of the vibration gyro 1.

The frequency synthesizer 10 is controlled in a manner that is
not illustrated in any more detail in order to carry out the
modulation process at 28 with a phase angle i and the
25   demodulation process at 29 with a phase angle q. This means
that an in-phase component I is demodulated at 28, and a
quadrature component Q is demodulated at 29.

However, the in-phase components and the quadrature components
30   are corrupted by variations in the delay times in the various
circuits involved. The measurement result, that is to say the
rotation rate signal, is therefore corrupted.

In order to avoid this, an adjustment process is carried out in
35   which correction variables k1 and k2, which are produced in a

device 41, are added to the filtered components by means of the adders 35, 36, with the correction values k1 and k2 being chosen such that they result in a phase shift in the excitation signal SD and thus also in the output signal SO. The changeover

5   switches 42 are then in the illustrated position. During the adjustment process, the predetermined value ranges of the correction values k1, k2 are passed through. At the same time, a check is carried out in a device 43 to determine whether the in-phase component and the quadrature component are each zero

10 or have assumed a minimum. If this is the case, the correction values k1, k2 which are produced in the device 41 are then stored in an EEPROM 44. During normal operation, the changeover switches 42 are in the right-hand position and the correction values as determined during the adjustment process are read

15 from the EEPROM 44 and are supplied to the adders 35, 36.